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Press release

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Melting ice sheets release tons of methane into the atmosphere

The Greenland Ice Sheet emits tons of methane over the summer, according to a new study published in Nature. Researchers – including a team from Université libre de Bruxelles – show that biological activity beneath the ice impacts the atmosphere far more than previously thought.

An international team of researchers led by the University of Bristol (UK), in collaboration with the Université Libre de Bruxelles (Belgium), Charles University (Czechia), the National Oceanography Centre (UK), Newcastle University (UK), Cardiff University (UK), University of Toronto (Canada), and Kongsberg Maritime sampled the meltwater that runs off a large catchment (> 600 km^2) of Greenland's Ice Sheet during the summer months.

By using novel sensors to measure methane in meltwater runoff in real time, they observed that methane was continuously exported from beneath the ice. Their study is published in *Nature*. While some methane had been detected previously in Greenland ice cores and in an Antarctic Subglacial Lake, **this is the first time that meltwaters produced in spring and summer in large ice sheet catchments have been reported to continuously flush out methane from the ice sheet bed to the atmosphere.** Researchers calculated that at least **six tons of methane** was transported to their measuring site from this portion of the Ice Sheet alone.

Methane gas (CH_4) is the third most important greenhouse gas in the atmosphere after water vapour and carbon dioxide (CO_2). Although, present in lower concentrations than CO_2, methane is approximately 20-28 times more potent. Therefore smaller quantities have the potential to cause disproportionate impacts on atmospheric temperatures. Most of the Earth's methane is produced by microorganisms that convert organic matter to CH_4 in the absence of oxygen, mostly in wetlands and on agricultural land, for instance in the stomachs of cows and rice paddies. The remainder comes from fossil fuels like natural gas.

Most studies on Arctic methane sources focus on permafrost, because these frozen soils tend to hold large reserves of organic carbon that could be converted to methane when they thaw due to climate warming. As they hold large reserves of carbon, liquid water, microorganisms and very little oxygen, ice sheets beds present the ideal conditions for creating methane gas. This latest study confirm that ice sheet beds are indeed atmospheric methane sources.

Prof. **Sandra Arndt from the BioGeosys Research Unit at Université libre de Bruxelles' Faculty of Sciences**, who co-authored the study, said: "*the finding that ice shields do not only host but also continuously evacuate large quantities of methane directly to the atmosphere is critical. Earth's ice sheets and glaciers (and in particular the Greenland Ice Sheet) are currently experiencing record melting. Yet, despite their potentially important role in the global climate system and alarming retreat, the way in which hydrological and biogeochemical processes under the ice interact to control the export methane over a melt season now and, in particular, in the future remains poorly understood. A major issue preventing future advances in this field is the capacity to model the processes which control these important dynamics of glacier systems. Unlike for instance, the oceans and atmosphere, no models of biogeochemical processes beneath ice currently exist. This seriously limits our ability to evaluate the present and future feedbacks of glacial methane emissions on climate*". At ULB, **Prof. Arndt (BioGeosys Research Unit, Faculty of Sciences) and Prof. Frank Pattyn (Glaciology Lab, Faculty of Sciences)** have joint forces to tackle this problem. Funded through a recently awarded

ARC (Action de Recherche Concertée) project supported by the *Fédération Wallonie-Bruxelles*, they have started to build the very first, mechanistic, hydrological-biogeochemical model framework for subglacial environments. The development of this new and innovative modeling tool will not only represent a step change in our ability to quantify and predict subglacial methane emissions. It will also allow ULB to position itself as a pioneer in ice-sheet biogeochemical modelling and, in combination with complementary research conducted within the two research units, will establish ULB as a hub for modelling coupled physical-biogeochemical dynamics and climate feedbacks in Polar regions.

The study published in Nature was led by Prof. Jemma Wadham, Director of Bristol's Cabot Institute for the Environment, who led the investigation, said: "*A key finding is that much of the methane produced beneath the ice likely escapes the Greenland Ice Sheet in large, fast flowing rivers before it can be oxidized to CO_2, a typical fate for methane gas which normally reduces its greenhouse warming potency*". Lead author Guillaume Lamarche-Gagnon, a PhD student from Bristol's School of Geographical Sciences, further adds: "*What is also striking is the fact that we've found unequivocal evidence of a widespread subglacial microbial system. Whilst we knew that methane-producing microbes likely were important in subglacial environments, how important and widespread they truly were was debatable. Now we clearly see that active microorganisms, living under kilometres of ice, are not only surviving, but likely impacting other parts of the Earth system*"

This research is a collaborative venture between the University of Bristol (UK), the Université libre de Bruxelles (Belgium), Charles University (Czechia), the National Oceanic Centre in Southampton (UK), the University of Toronto (Canada), Cardiff University (UK), and Kongsberg Maritime Contros (Germany). It was funded principally by the Natural Environment Research Council (UK), with additional funds from the Leverhulme Trust (UK), the Czech Science Foundation, the Natural Sciences and Engineering Research Council of Canada, and the Fond de Recherche Nature et Technologies du Québec (Canada).

Reference:
'Greenland melt drives continuous export of methane from the ice sheet bed'
Guillaume Lamarche-Gagnon, Jemma L. Wadham, et al.
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